

## DISTINGUISHED LECTURE SERIES

Winter Term 2021/2022

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### **Design of magnetic tunnel junctions for microwave detectors, Physical Unclonable Functions, and logic operations**

Magnetic tunnel junction (MTJ) can be used for different purposes and applications beyond memory applications. In a recent joint project with the Italy Space Agency, we have developed and optimized MTJs for their use as high sensitive and radiational hardness detectors (spintronic diodes) in space applications. In this talk, I will review the state of the art of spintronic diodes focusing on high-detection sensitivity at room temperature, without any external bias fields, and for low-input power (micro-Watts or lower) [1]. Another potential application of MTJs is toward security, by realizing a novel class of Physical Unclonable Functions (PUF). The realization proposed here is based on a three terminal MTJ device where the random bit is written by the spin-hall effect (SHE), while the bit reading is achieved via the magnetoresistive effect. We show the condition to achieve a PUF state with 50% of up and 50% of down state randomly distributed in an MTJ matrix. The proposed low cost and energy efficient device is scalable to be integrated in advanced CMOS technological nodes, reconfigurable, radiation hardness, robust against voltage variations and temperature fluctuations [2]. Finally, I will briefly discuss logic operations which can be performed with MTJ devices for in-memory computing. The basic structure consists of one MTJ, exhibiting Voltage Controlled Magnetic Anisotropy, in series connection with a MOSFET access device. The IMP and NOT logic operations can be performed without any external magnetic field by supplying a proper bias voltage to the circuit structure. This innovative solution enables higher energy-delay efficiency and better integration density than conventional CMOS-based computational architectures [3].

[1] L. Zhang, B. Fang, et al., Applied Physics Letters, Vol. 113(10), pp. 102401-1-4 (2018). doi:10.1063/1.5047547.

[2] G. Finocchio, T. Moriyama, et al., Journal of Applied Physics, Vol. 128, 033904 (2020). doi:10.1063/5.0013408.

[3] F. Cutugno, E. Garzon, R. De Rose et al., IEEE Magnetic Letters, doi:10.1109/LMAG.2021.3118562.

Date: **Monday, February 07, 2022**

Time: **04:00 pm**

Venue: **On site 46/HS 270 or Online via Zoom; the speaker is joined by Zoom**

Meeting ID: **641 9279 3075**, Passcode: **4Ko!!2122**, Link:

**<https://uni-kl-de.zoom.us/j/64192793075?pwd=WnIJYWZh4ZENmV2tWZk12UolHRUthUTog>**